XI. A STUDY OF THE MALE GENITALIA OF CERTAIN ANTHIDIINE BEES

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(Plates XXXI-XXXIII)

Formerly all the bees of this group were referred to the genus *Anthidium* Fabricius. More recently some of them have been separated into other genera and subgenera, principally based upon external characters, including the mouth-parts. An examination of the genitalia shows that structurally some of them are remarkably distinct. This has suggested the separation of two additional groups, which are defined below. The number of species, the genitalia of which have been studied, is not large, but represents the types of these two new groups, as well as typical forms in other groups.

In the preparation of this paper no attempt has been made to compare the structure of the cardo, spatha, and volsellæ in any detail, except in the case of *Dianthidium sayi*, *R. siculum*, and *A. chrysurum*.

My studies of the genitalia of the above-named species have shown that the volsellæ are not a part of the stipes, but are, instead, definite structures, which arise independently from the cardo. The spatha has been found to partly cover the sagittæ on both the dorsal and ventral surfaces. In some species the spatha is continuous around the sagittæ, but more often it is in two parts with the sagittæ placed between them.

Before concluding these preliminary remarks I wish to gratefully acknowledge my indebtedness to Prof. Theodore D. A. Cockerell, whose unfailing kindness and helpful advice during the preparation of this paper I shall never forget.

KEY TO CERTAIN GENERA AND SUBGENERA OF THE ANTHIDIINÆ BASED UPON THE GENITALIA

1. Spatha absent or not evident ..... 2.
   Spatha, present and conspicuous ..... 3.

2. Volsellæ large ..... *Paranthidium*, Ckll.
   Volsellæ quite small, almost invisible ..... *Notanthidium*, nov.

3. Sagittæ unusually long and narrow, at least twice as long as stipes..... *Callanthidium*, Ckll.
   Sagittæ not thus elongated..... 4.

4. Stipes with a distinct notch in upper margin. *Rhodanthidium*, nov.
   Stipes without a distinct notch in upper margin..... 5.

5. Stipes having a dentiform lobe on inner margin midway between tip and base..... 6.
   Stipes lacking a dentiform lobe..... 7.

6. Spatha completely surrounding sagittæ.. *Anthodioctes*, Holmberg
   Spatha not projecting beyond sagittæ laterally..... *Hypanthidium*, Ckll.

7. Inner margin of head of stipes projected mesad into a beak-like structure.... *Heteranthidium*, Ckll.
   Head of stipes not so..... 8.

8. Spatha lying in a depression of the sagittæ... *Dianthidium*, Ckll.
   Spatha enclosed between the sagittæ..... *Anthidium*, Fabr.

DIANTHIDIUM Cockerell (*sens. strict.*)

Dianthidium COCKERELL, Ann. Mag. N. H., (7), V, 1900, p. 412. (Genotype *Anthidium curvatum* SMITH = *A. interruptum* (Say), now superseded by *D. sayi* COCKERELL.

1. **Dianthidium sayi** Cockerell (Type of genus) (Pl. XXXI, fig. 1).

Dianthidium sayi COCKERELL, Can. Ent., April, 1907, p. 136.

Megachile interrupta SAY, not Spinola, nor *Anthidium interruptum* Fabricius: also = *curvatum* "Smith," *Auct. part.*, but the true *curvatum* is restricted to a species from Georgia, *Cf.* SCHWARZ, Amer. Mus. Novit., 226, 1926, p. 7.

Stipes erect, narrow at base, but broadening out into somewhat of an oar-shaped structure, inner angle of tip quite rounded, outer angle extended into a slight prolongation. Sagittæ distinctly longer than the stipites and are the same distance apart throughout their entire length. A distinct depression is present in the sagittæ in which the spatha lies. This latter structure partly covers the sagittæ on the upper and lower surfaces and has numerous spine-like projections upon its surface. The cardo surrounds the lower portions of the sagittæ, that is, those parts by which the sagittæ are attached to the base, and is a continuous structure. The upper portion of the cardo supports the stipites and the lower portion the volsellæ. Long hairs are found on the stipites and volsellæ, those on the latter being very

few in number. A number of small hairs, spine-like in appearance, are found on the sagittæ.

Habitat; Georgia, Texas, Kansas, Colorado, etc.

2. **Dianthidium pudicum** (Cresson). (Plate XXXI, fig. 2).

Anthidium pudicum CRESSON, Trans. Am. Ent. Soc., VII, 1879, p. 208.
Dianthidium pudicum COCKERELL, Ann. Mag. N. H. (8) V, 1900, p. 413.

This species is very similar to *D. sayi* and undoubtedly belongs to the same genus. Sagittæ extending beyond the stipites and with a depression in which the spatha lies; stipites erect and oar-shaped. The only apparent difference of any consequence is that the volsellæ are quite pointed, while in *D. sayi* they are rounded.

Habitat: Nevada, Colorado, etc.

3. **Dianthidium sinapinum** (Cockerell). (Plate XXXI, fig. 3).

Dianthidium sinapinum COCKERELL, Ann. Mag. N. H. (8) VIII, 1911, p. 179.

Although this species differs considerably from *D. sayi* in the appearance of its various parts, the general contour of these parts is somewhat the same in both. Instead of standing in an upright position, the stipites are pointed outward, yet their simple outline is enough like that of *D. sayi* to warrant the placing of the bee in this genus. Although the sagittæ in this species are shorter than the stipites, whereas in *D. sayi*, they are decidedly longer, the general structure is the same in the two, the longest point being on the inner margin; a depression for the spatha to lie in is present in both. Volsellæ are found in this species, but they are without hairs.

Habitat: India.

NOTANTHIDIUM subgen. nov.

Genotype: *Anthidium steloides* (Gay)

Female: Black ventral scopa; mandibles very long and distorted; clypeus convex in middle, smooth and polished; the abdomen is narrow and parallel-sided.

Male: Keel of sixth segment obtusely bilobed; seventh not projecting; pulvilli small; basal nervure meeting nervulus; second recurrent going very little beyond second cubital.

Genitalia: The stipites point outward and are irregular in outline; sagittæ becoming narrow at tip and spreading far apart; volsellæ much reduced in size; spatha apparently lacking.

4. **Notanthidium steloides** (Gay). (Plate XXXI, fig. 4).

Anthidium steloides GAY, Fauna Chileña, VI, 1851, p. 182.

Stipites narrow at base, with a dentiform lobe on the outer surface near the base; the inner curve of this lobe following the upper curve

of the outer part of the cardo. This lobe with the aid of a wider lobe midway up the inner margin of the stipes tends to broaden out the structure; it terminates rather bluntly, lacking any points or angles, and is about one-half the length of the sagittæ. The sagittæ meet at base, but rapidly spread apart, extending far beyond the stipes; tip rounded, but very narrow, due to the converging of the outer and inner margins; a definite outward projection midway up the outer margin causes them to become wider at this point. With the exception of the base this is the widest point on the sagittæ. A few hairs are found near the tip. Volsellæ present in a much reduced state, projecting but slightly above the base of the stipes. Spatha apparently lacking.

Habitat: Chile.

RHODANTHIDIUM subgen. nov.

Genotype: *Anthidium siculum* (Spinola)

Male: End of sixth segment of abdomen broadly truncate; seventh projecting and beak-like; pulvilli large; basal nervure going a little basad of nervulus; second recurrent nervure going far beyond end of second cubital cell.

Genitalia: Stipes upright, very broad, and with a deep notch in upper margin. Sagittæ broad at base and narrow at tip, ending in hooked points. Volsellæ in two parts, projecting but little above cardo. Spatha very regular in outline.

5. **Rhodanthidium siculum** (Spinola). (Plate XXXI, fig. 5).

Anthidium siculum SPINOLA, Ann. Soc. Ent. France, VII, 1838, p. 525.

The stipites are very broad and characterized by a deep notch in the upper margin; slightly inclined toward sagittæ; hairs found only on the stipes. Sagittæ quite broad at the base and joined together only at this point, gradually narrowing and ending in a hooked point. The spatha regular in outline and found both on top of and beneath the sagittæ, but not extending as far as do the sagittæ. Two dark, round structures are found on the spatha, which apparently have been broken away from something, but just what this is I am unable to explain. There is also present on the spatha in the center another single round object, larger than the paired ones and decidedly different in structure, for which I also am unable to account. Cardo not a continuous structure, the upper portion very broad and supporting the sagittæ, but the lower portion very much smaller and ending in a point soon after the turn is made. Although quite small the lower portion supports a larger and more complicated volsella than is found in *Dianthidium sayi*, for here the structure is compound and is barren of hairs.

Habitat: Egypt, Morocco.

PARANTHIDUM T. D. A. & W. R. Cockerell

Paranthidium T. D. A. & W. R. COCKERELL, Ann. Mag. N. H. (7) VII, 1901, p. 50. (Genotype *Dianthidium perpictum* Cockerell.)

6. **Paranthidium perpictum** (Cockerell). (Plate XXXI, fig. 8).

Paranthidium perpictum COCKERELL, Tables for Determ. N. Mex. Bees, Bull. Sci. Lab. Dennison Univ., XI; also Bull. Univ. N. Mex., 1898, p. 63.

Stipites extending slightly beyond sagittæ; the direction of the stipites, as they leave the cardo, is upward and outward, but an angle occurs about midway, which causes the direction to become inward rather than outward; the place of change of direction is marked by a distinct depression on the inner margin; the upper part of each stipes becomes broader and suggests a square; a narrow projection on the outer margin has both an upper and a lower lobe; the straight margins and distinct angles tend to distinguish this genus from all others which have been studied. Sagittæ very simple, arising from a common base and dividing almost immediately into long, narrow, pyramid-shaped structures, having a few hairs on the outer border at the tip. Volsellæ wider than either of the above-mentioned parts, but very short, almost cylindrical, having but a slight depression on the upper side. Spatha apparently lacking.

Habitat: Colorado, etc.

ANTHODIOCTES Holmberg

Anthodioctes HOLMBERG, Ann. Mus. Buenos Aires, (3) II, 1903, p. 435. (Genotype *A. dasygastrinus* Holmberg, *l.c.*)

7. **Anthodioctes chrysurus** Cockerell[1]. (Plate XXXI, fig. 7).

Stipes inclined slightly outward, very irregular in outline, having two dentiform lobes on the inner margin. Sagittæ not projecting as far as the stipites, connected by a median plate, which has not been recognized in any other species. Spatha very broad, extending beyond the outer borders of the sagittæ, so that it completely surrounds them. Spatha entirely different from that of all other species, which have been studied, in that a row of long hairs is present along the entire upper border. The upper portion of the cardo supports the stipites, but the under portion is entirely free from the volsellæ. A very peculiar hair structure is present here, which has been recognized in no other species; it is found in the middle of the organ, but does not

[1]A small species with the male clypeus partly black; lateral third of anterior margin of mesothorax, scutellum, and axillæ, and abdominal bands, orange; first abdominal segment black. A fuller description will eventually appear in the Proc. U. S. N. M. T. D. A. COCKERELL.

extend as far as the upper border of the spatha; a median split occurs in the lower one-third of this structure.

Habitat: Bolivia.

CALLANTHIDIUM Cockerell

Callanthidium COCKERELL, Proc. Cal. Acad. Sci., (4) XIV, 1925, p. 365. (Genotype *Anthidium illustre* Cresson.)

8. **Callanthidium illustre** (Cresson). (Plate XXXIII, fig. 2).

Anthidium illustre CRESSON, Trans. Am. Ent. Soc., VII, 1879, p. 208.

Stipes short and broad, with an obliquely truncate lobe at the tip; long plumed hairs direct themselves toward the sagittæ. The volsellæ likewise point in this direction, rather than in the direction of the stipes, as in *C. conspicuum*. The arch formed at the base of of the sagittæ is slightly pointed, rather than rounded, and is formed by a single structure, instead of two projections; a depression on the inner surface of the sagitta is found a short distance above the dentiform lobe and continues to the end of the structure.

9. **Callanthidium conspicuum** (Cresson). (Plate XXXIII, fig. 1).

Anthidium conspicuum CRESSON, Trans. Am. Ent. Soc., VII, 1879, p. 207.

Stipes short and broad; long plumed hairs are placed nearly at right angles to the surface from which they grow. Basal portion of sagittæ rounded, forming an arch on the inner margins, which does not entirely meet. Above this arch are found the dentiform lobes, which cause the sagittæ to broaden out at this point. Above these lobes the inner margins of the sagittæ are almost entirely straight, having no projections nor indentations. The volsellæ run parallel to the stipites and point in the same general direction. Spatha present.

Habitat: Nevada, California.

HYPANTHIDIUM Cockerell

Hypanthidium COCKERELL, Ent. News, XV, 1904, p. 292. (Genotype *Anthidium flavomarginatum* Smith.)

10. **Hypanthidium braunsi** (Friese). (Plate XXXI, fig. 9).

Anthidium braunsi FRIESE, Zeitschr. für Syst. Hymenopterologie, &c., IV, 1904, p. 103.

Stipes nearly erect; quite narrow at base, but broadening out by means of two inner lobes and a swelling on the outer margin; the structure becoming narrowed at tip, giving the entire upper portion a conical shape; hairs very short and rather few in number. Sagittæ much shorter than the stipites and inclined toward each other; a very sharp point on the inner margin, causing them to almost meet at this

point; sagittæ ending in a rather blunt point with several hairs upon it. Volsellæ lacking. Spatha narrow at base, expanding a little at top, which is rounded, extending but a short distance beyond inner points of sagittæ.

Habitat: South Africa.

HETERANTHIDIUM Cockerell

Heteranthidium COCKERELL, Ent. News, XV, 1904, p. 292. (Genotype *Anthidium dorsale* Lepeletier.)

11. **Heteranthidium zebratum** (Cresson). (Plate XXXII, fig. 1).

Anthidium zebratum CRESSON, Trans. Am. Ent. Soc., IV, 1872, p. 270.

This species is distinct from all others in having extremely large stipites, which enclose the comparatively small sagittæ between them; upper and lower margins of the beak-like projections are well covered with plumed hairs. Small hairs are found on the sagittæ.

Habitat: Texas, Colorado, etc.

12. **Heteranthidium occidentale** (Cresson). (Plate XXXII, fig. 2).

Anthidium occidentale CRESSON, Trans. Am. Ent. Soc., I, 1868, p. 386.

Stipes much narrower than that of the previous species and without hairs on the under surface of the beak-like projection. Sagittæ much broader and longer than those of *H. zebratum* and extending some distance beyond the stipites. Thus these two species, so similar in general appearance, are seen to be very distinct in their genitalia.

Habitat: New Mexico, Colorado, Nevada.

ANTHIDIUM Fabricius

Anthidium FABRICIUS, Systema Piezatorum, 1804, p. 364. (Genotype *Apis manicata* Linnæus, Syst. Nat., Ed. X, 1758, p. 577.)

13. **Anthidium manicatum** (Linnæus) *l.c.* (Plate XXXII, fig. 5).

Apis manicata LINNÆUS, *l. c.*

Stipes erect and rather narrow; small point on upper margin. Sagittæ characterized by a sharply pointed tip. Volsellæ small and inclined toward sagittæ. Spatha extending almost as far as the sagittæ and more pointed than in the species hereinafter described.

Habitat: Europe.

14. **Anthidium pondreum** (Titus). (Plate XXXII, fig. 4).

Anthidium pondreum TITUS, Ent. News, XIII, 1902, p. 169.

Stipites club-shaped, pointing outwardly, provided with numerous hairs. Sagittæ erect, with a median downwardly projecting lobe,

which ends in a point; midway up the inner margin a narrow hooked projection, placed at right angles to the sagitta. The volsellæ are rather small, erect. Spatha cone-shaped, and almost completely surrounded by the sagittæ with their median projections.

Habitat: Central Rocky Mountain States.

15. **Anthidium simulans** (Cockerell). (Plate XXXII, fig. 3).

Anthidium simulans COCKERELL, Ann. Mag. Nat. Hist., (9) XVII, 1926, p. 217.

Stipes erect, very broad, with numerous plumed hairs, upper margin pointed. Volsellæ small, inclined toward sagittæ. Sagittæ erect, ending in a blunt point, with a median downwardly projecting lobe, which is narrower than that seen in *A. pondreum*. Spatha confined between lower portions of sagittæ.

Habitat: Peru.

16. **Anthidium porteræ** (Cockerell). (Plate XXXII, fig. 6).

Anthidium porteræ COCKERELL, Ann. Mag. N. H. (7) V, 1900, p. 44.

Stipites pointing outward, having the same width throughout their length, upper margin distinctly pointed. Sagittæ medially inclined and ending rather obtusely. Volsellæ erect and quite large. Spatha very low and broad, having a distinct median cleft in upper margin.

Habitat: Central Rocky Mountain States.

Species incertæ sedis.

17. **Anthidium sibiricum** (Eversmann). (Plate XXXI, fig. 6).

Anthidium sibiricum EVERSMANN, Bull. Soc. Nat. Moscou. XXV, 1852, p. 85; COCKERELL, Ann. Mag. N. H. (9) XIII, 1924, p. 526.

This bee is entirely different from the type of the subgenus *Rhodanthidium* in all outward respects, but a notch is found in the upper margin of the stipes, which makes its classification under *Rhodanthidium* possible. Further investigation should be carried out in the case of this species.

18. **Anthidium sticticum** (Fabricius).

Apis stictica FABRICIUS, Mant. Ins., 1787, p. 302.

Dianthidium sticticum FABRICIUS, Syst. Piez., 1804, p. 366; LEPELETIER, Hist. Nat. des Hym., H. 1841, p. 352.

The genitalia of this bee have not been studied, but the bee is similar in all outward respects to *Rhodanthidium siculum* (Spinola), and probably should be included in *Rhodanthidium*.

EXPLANATION OF PLATE XXXI.

(All figures are magnified twenty times).

a = sagitta; b = spatha; c = stipes; d = volsella; e = cardo.

Fig. 1. *Dianthidium sayi* Cockerell, ♂

Fig. 2. *Dianthidium pudicum* (Cresson), ♂.

Fig. 3. *Dianthidium sinapinum* Cockerell, ♂.

Fig. 4. *Notanthidium steloides* (Gay), ♂.

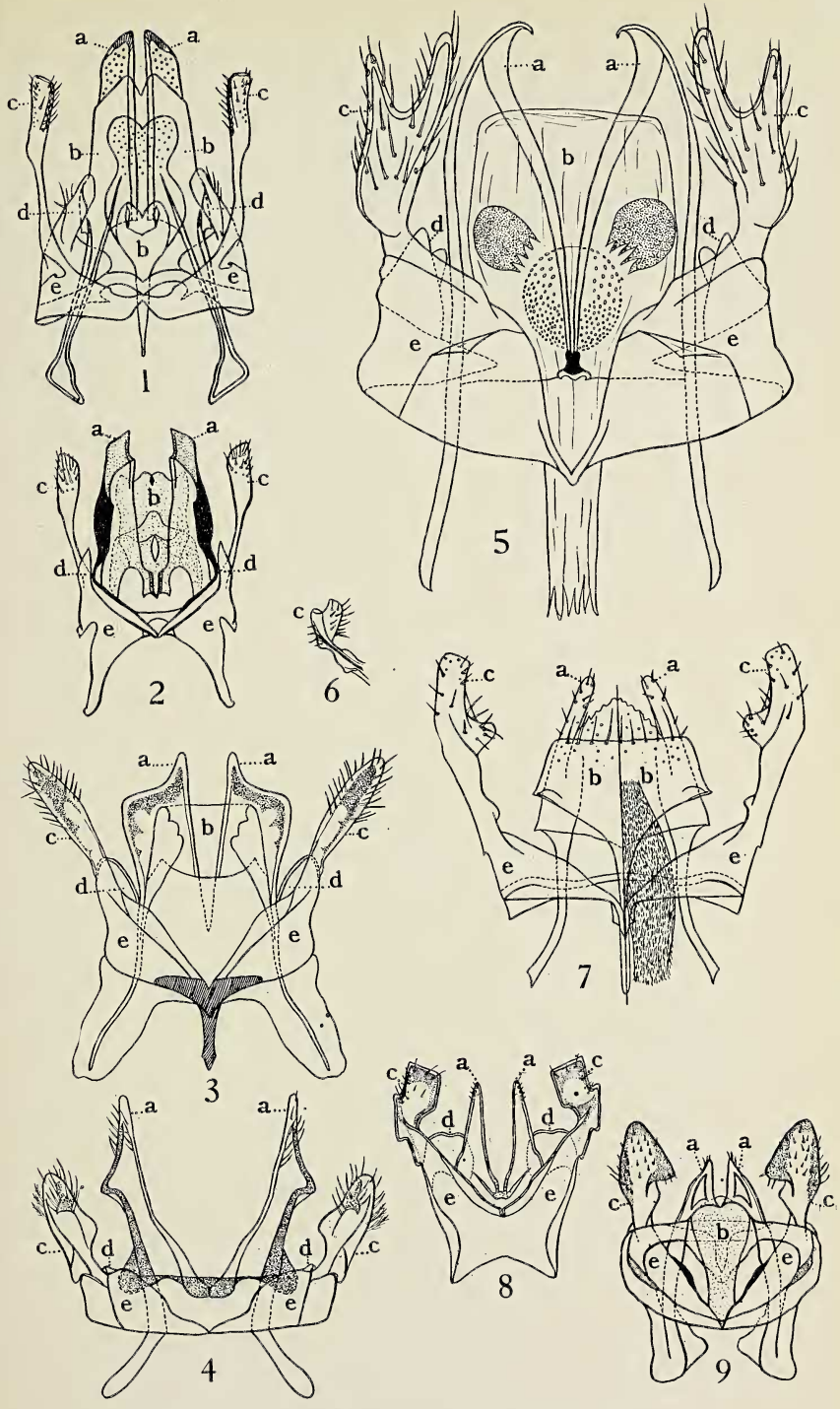
Fig. 5. *Rhodanthidium siculum* (Spinola), ♂.

Fig. 6. *Rhodanthidium sibiricum*? (Eversmann), ♂.

Fig. 7. *Anthodioctes chrysurus* Cockerell, ♂.

Fig. 8. *Paranthidium perpictum* Cockerell, ♂.

Fig. 9. *Hypanthidium braunsi* (Friese), ♂.



Male genitalia of Anthidiinæ

EXPLANATION OF PLATE XXXII.

(All figures are magnified twenty times).

a = sagitta; b = spatha; c = stipes; d = volsella; e = cardo.

Fig. 1. *Heteranthidium zebratum* (Cresson), ♂.
Fig. 2. *Heteranthidium occidentale* (Cresson), ♂.
Fig. 3. *Anthidium simulans* Cockerell, ♂.
Fig. 4. *Anthidium pondreum* Titus, ♂.
Fig. 5. *Anthidium manicatum* (Linnæus), ♂.
Fig. 6. *Anthidium porterœ* Cockerell, ♂.